PESTICIDE SURFACE WATER AND SEDIMENT QUALITY REPORT

JUNE 2002 SAMPLING EVENT

Richard J. Pfeuffer
Francine Matson
South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406

Pesticide Monitoring Project Report
June 2002 Sampling Event

Executive Summary

As part of the District's quarterly ambient monitoring program, unfiltered water and sediment samples from 39 sites were collected from June 2 to June 5, 2002, and analyzed for over sixty pesticides and/or products of their degradation. The herbicides ametryn, atrazine, bromacil, diuron, hexazinone, metolachlor, norflurazon, prometon, and simazine, along with the insecticides/degradates atrazine desethyl, atrazine desisopropyl, fonofos, and metalaxyl were detected in one or more of these surface water samples.

The herbicides ametryn and norflurazon, together with the insecticides/degradates DDD, DDE, DDT, alpha endosulfan, beta endosulfan, endosulfan sulfate, and ethion were found in the sediment at several locations, along with two PCB compounds. All but one of the DDE and the two PCB compound sediment concentrations were at levels associated with the potential for impacting wildlife when compared to coastal sediment quality assessment guidelines. All of the DDD and DDT detections were of a magnitude considered to represent significant and immediate hazard to aquatic organisms in coastal sediments. However, there are no corresponding freshwater sediment quality assessment guidelines to further evaluate potential hazards at these particular sampling sites.

The compounds and concentrations found are typical of those expected from intensive agricultural activity.

Background and Methods

The District's pesticide monitoring network includes stations designated in the Everglades National Park Memorandum of Agreement, the Miccosukee Tribe Memorandum of Agreement, the Lake Okeechobee Operating Permit, and the non-Everglades Construction Project (non-ECP) permit. The District's canals and marshes depicted in Figure 1 are protected as Class III (fishable and swimable) waters, while Lake Okeechobee is protected as a Class I drinking water supply. Water Conservation Area 1 (WCA1) and the Everglades National Park are also designated as Outstanding Florida Waters, to which anti-degradation standards apply. Surface water and sediment are sampled quarterly and semiannually, respectively, upstream at each structure identified in the permit or agreement.

Sixty-six pesticides and degradation products were analyzed for in samples from all of the 39 sites (Figure 1). The analytes, their respective minimum detection limits (MDL), and practical quantitation limits (PQL) are listed in Table 1. All the analytical work is performed by the Florida Department of Environmental Protection (FDEP) Central Laboratory in Tallahassee Florida. The reader is referred to the *Quality Assurance Evaluation* section of this report for a summary of any limitations on data validity that might influence the utility of these data. Site G211 was deleted from the network as it was considered analogous to site S331, which is only four miles downstream.

Each pesticide's description and possible uses and sites of application are taken from Hartley and

Kidd (1987). The Florida Ground Water Guidance Concentrations (FGWGC) (FDEP, 1994a) are listed to provide an indication at what level these pesticide residues could possibly impact human health, based on drinking water consumption or other routes of exposure (e.g., inhalation, ingestion of food residues, dermal uptake). Primary ground water standards are enforceable ground water standards, not screening tools or guidance levels. To evaluate the potential impacts on aquatic life, due to the pulsed nature of exposure, the maximum observed concentration is compared to the Criterion Maximum Concentration published by the USEPA under Section 304 (a) of the Clean Water Act, if available, or the lowest EC_{50} or LC_{50} reported in the summarized literature. Sediment concentrations are compared to coastal sediment quality assessment guidelines (FDEP, 1994b), as there are no corresponding freshwater sediment quality assessment guidelines. A value below the threshold effects level (TEL) should not have an impact on wildlife. The value between the TEL and probable effects level (PEL) has a possibility for impacts, while those exceeding the PEL have a substantial probability for impacting wildlife. This summary covers surface water and sediment samples collected from June 2 to June 5, 2002.

Findings and Recommendations

At least one pesticide was detected in surface water at 35 of the 39 sites and in sediment at 14 of the 36 sites. Sediment samples are not routinely collected at GORDYRD, CR33.5T, NSIDWC06, and NSIDWC07. The concentrations of the pesticides detected at each of the sites are summarized for the surface water and sediment in Tables 2 and 3, respectively. All of these compounds have previously been detected in this monitoring program, with the exception of fonofos and prometon. Although fonofos and prometon have been analyzed in the surface water since 1987 and the December 2001 sampling event, respectively, this is the first surface water detection for both compounds.

All but one of the DDE, and the two PCB compound sediment concentrations are usually associated with the potential for impacting wildlife when compared to coastal sediment quality assessment guidelines. All of the DDD and DDT detections were of a magnitude considered to represent significant and immediate hazard to aquatic organisms in coastal sediments. However, there are no corresponding freshwater sediment quality assessment guidelines to further evaluate potential hazards at the District's sampling sites.

The above findings must be considered with the caveat that pesticide concentrations in surface water and sediment may vary significantly in relation to the timing and magnitude of pesticide application, rainfall events, pumping and other factors, and that this was only one sampling event. The possible long term or chronic toxicity impacts are also reported based on the single sampling event and do not take into account previous monitoring data.

Usage and Water Quality Impacts

Ametryn: Ametryn is a selective terrestrial herbicide registered for use on sugarcane, bananas, pineapple, citrus, corn, and non-crop areas. Most algal effects occur at concentrations > 10 µg/L (Verschueren, 1983). Environmental fate and toxicity data in Tables 4 and 5 indicate that ametryn (1) is lost from soil relatively easily by leaching, surface adsorption, and in surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data includes a 96 hour LC_{50} of 14.1 mg/L for goldfish

(Hartley and Kidd, 1987). The ametryn surface water concentrations found in this sampling event ranged from 0.010 to 0.024 μg/L. Using these criteria, these surface water levels should not have an acute, detrimental impact on fish or aquatic invertebrates. The sediment concentrations ranged from 4.0 to 23 μg/Kg. However, no sediment quality assessment guidelines have been developed for ametryn.

Atrazine: Atrazine is a selective systemic herbicide registered for use on pineapple, sugarcane, corn, rangelands, ornamental turf and lawn grasses, and non-crop areas. Environmental fate and toxicity data in Tables 4 and 5 indicate that atrazine (1) is easily lost from soil by leaching and in surface solution, with moderate loss from surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96 hour LC_{50} of 76 mg/L for carp, 16 mg/L for perch and 4.3 mg/L for guppies (Hartley and Kidd, 1987). Also, in a flow-through bioassay, the maximum acceptable toxicant concentration (MATC) of atrazine was 90 and 210 μg/L for bluegill and fathead minnow (Verschueren, 1983). The atrazine surface water concentrations found in this sampling event at 33 of the 39 sampling locations, ranged from 0.012 to 2.8 μg/L. Using these criteria, these surface water levels should not have an acute or chronic detrimental impact on fish or invertebrates. Atrazine was not quantified in the sediment.

Atrazine desethyl (DEA) and atrazine desisopropyl (DIA) are biotic degradation products of atrazine. These degradation products are both persistent and mobile in water; however, DEA is more stable and the dominant initial metabolite. Since DEA and DIA are structurally and toxicologically similar to atrazine, the concentrations of total atrazine residue (atrazine + DEA + DIA) may also be a significant consideration in the surface water environment. The DEA to atrazine ratio (DAR), on a molar basis, has been suggested as an indicator of nonpoint-source pollution of groundwater (Adams and Thurman, 1991) and as a tracer of ground water discharge into rivers (Thurman et al., 1992). Goolsby et al. (1997) determined that low DAR values, median <0.1, occur in streams during runoff shortly after application of atrazine. Higher DAR values, median about 0.4, occur later in the year after considerable degradation of atrazine to DEA has occurred in the soil. The low median DAR ratio (0.1) at the locations where both atrazine and DEA were detected, suggests minimum degradation of atrazine (Table 6). Most of the sites fall in this category with the exception of S5A, FECSR78, and S2. The DAR value of 0.3 suggests that some degradation of atrazine has occurred in this basin. However, these general guidelines were developed based on observations in Midwest watersheds in northern temperate climates with different soil and water management regimes as well as higher atrazine water concentrations. Applications to the south Florida environment should be made with caution.

Bromacil: Bromacil is a terrestrial herbicide registered for use on pineapple, citrus, and non-crop areas. Environmental fate and toxicity data in Tables 4 and 5 indicate that bromacil (1) is easily lost from soil by leaching, with moderate loss from surface adsorption or surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data includes a 96 hour LC_{50} of 164 mg/L for carp (Hartley and Kidd, 1987). The highest concentration of bromacil detected in the surface water during this sampling event was at S79 (0.53 μg/L). Using these criteria, these levels should not have an acute or

chronic detrimental impact on fish. Bromacil was not quantified in the sediment.

DDD, DDE, DDT: DDE is an abbreviation of **d**ichloro**d**iphenyldichloro**e**thylene [2,2-bis(4-chlorophenyl)-1,1-dichloroethene]. DDE is an environmental dehydrochlorination product of DDT (**d**ichloro**d**iphenyl**t**richloroethane), a popular insecticide for which the USEPA cancelled all uses in 1973. The large volume of DDT used, the persistence of DDT, DDE and another metabolite, DDD (**d**ichloro**d**iphenyl**d**ichloroethane), and the high K_{oc} of these compounds accounts for the frequent detections in sediments. The large hydrophobicity of these compounds also results in a significant bioaccumulation factor (Table 4). In sufficient quantities, these residues have reproductive effects in wildlife and carcinogenic effects in many mammals.

Sediment quality assessment guidelines have been developed for several metals and organic compounds in coastal sediments (FDEP, 1994b). The DDD concentrations detected range from 11 to 91 μg/Kg. Any value, which is between the TEL (1.2 μg/Kg) and PEL (7.8 μg/Kg), have the possibility for impacting wildlife. All of these event detections exceed the PEL and are considered to represent significant and immediate hazard to aquatic organisms.

The TEL is 2.1 μg/Kg and the PEL is 374 μg/Kg for DDE in coastal sediments. All but one (1.9 μg/Kg at G94D) of the DDE concentrations detected (3.9 to 300 μg/Kg) are between the TEL and PEL. The levels between the TEL and PEL have the possibility for impacting wildlife as they have exceeded the threshold level, while the one concentration below the TEL should not impact wildlife.

The only DDT concentration detected (11 μg/Kg at S5A) exceeds the PEL (4.8 μg/Kg). This level is considered to represent a significant and immediate hazard to aquatic organisms.

Diuron: Diuron is a selective, systemic terrestrial herbicide registered for use on sugarcane, bananas, and citrus. Environmental fate and toxicity data in Tables 4 and 5 indicate that diuron (1) is easily lost from soil in surface solution, with moderate loss from leaching or surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data includes a 96-hour LC_{50} of 25 mg/L for guppies (Hartley and Kidd, 1987). Crustaceans are affected at lower concentrations with a 48 hour LC_{50} of 1.4 mg/L for water fleas and a 96 hour LC_{50} of 0.7 mg/L for water shrimp (Verschueren, 1983). Most algal effects occur at concentrations > 10 μg/L (Verschueren, 1983). The highest surface water concentration of diuron found during this sampling event was 0.35 μg/L (Table 2). Using these criteria, this level should not have an acute, harmful impact on fish or algae. Diuron was not detected in the sediment.

Endosulfan: Endosulfan is a non-systemic insecticide and acaricide registered for use on many crops, including beans, tomatoes, corn, cabbage, citrus, and ornamental plants. Technical endosulfan is a mixture of the two stereoisomeric forms, the α (alpha) and the β (beta) forms. Endosulfan is highly toxic to mammals, with an acute oral LD_{50} for rats of 70 mg/Kg (Hartley and Kidd, 1987). The Soil Conservation Service rates endosulfan with an extra small potential for loss due to leaching, a large potential for loss due to surface adsorption and a moderate potential for loss in surface solution (Table 4). β-endosulfan's water solubility and Henry's

constant indicate volatilization may be significant in shallow waters. A bioconcentration factor of 1,267 indicates a low to moderate degree of accumulation in aquatic organisms (Lyman et al., 1990). Endosulfan (α and β) was detected in the sediment at S178 (Table 2). However, no sediment quality assessment guidelines have been developed for endosulfan as insufficient data exists.

Endosulfan sulfate: Endosulfan sulfate is an oxidation metabolite of the insecticide endosulfan. The water solubility and Henry's constant indicate that endosulfan sulfate is less volatile than water and concentrations will increase as water evaporates (Lyman et al., 1990). Endosulfan sulfate has a relatively high degree of accumulation in aquatic organisms (Table 4). The only sediment detection occurred at S178 (24 μg/Kg). However, no sediment quality assessment guidelines have been developed for endosulfan sulfate.

Ethion: Ethion is a non-systemic acaricide and insecticide registered for use on several fruits, citrus, and vegetables. The use of ethion on citrus has been cancelled (Federal Register, March 22, 2002). By December 31, 2004, all use of existing stocks of the end-use products is prohibited. Environmental fate and toxicity data in Tables 3 and 4 indicate that ethion (1) is strongly sorbed to soil and therefore can accumulate in sediments; (2) is slightly toxic to mammals, relatively toxic to fish and extremely toxic to Daphnia; and (3) bioconcentrates to a limited extent. Several sources of toxicity information have shown both agreement and disagreement of these laboratory tests. No ethion was detected in the surface water. Ethion was detected in the sediment at S99 (5.1 μg/Kg) and S80 (12 μg/Kg). However, no sediment quality assessment guidelines have been developed for ethion.

Fonofos: Fonofos (Dyfonate) is a soil insecticide primarily used on corn, with secondary uses on sugarcane, turf, and some vegetable crops. All products were cancelled effective November 1998. Environmental fate and toxicity data in Tables 4 and 5 indicate that fonofos (1) is not readily lost from soil by leaching or surface adsorption, with moderate loss from surface solution; (2) is relatively toxic to mammals and fish; and (3) does not bioconcentrate significantly. The only concentration of fonofos detected (0.021 μg/L at NSIDWC07) should not have an acute impact on fish.

Hexazinone: Hexazinone is a non-selective contact herbicide that inhibits photosynthesis. Registered uses include sugarcane, pineapple, and non-crop areas. Environmental fate and toxicity data in Tables 4 and 5 indicate that hexazinone (1) is easily lost from soil by leaching, with moderate loss from surface adsorption or surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Hexazinone is practically non-toxic to freshwater invertebrates with an EC_{50} of 145 mg/l for *Daphnia magna* (U.S. Environmental Protection Agency, 1988). The highest surface water concentration detected in this sampling event at FECSR78 (0.071 μg/L) should not have an acute impact on fish or aquatic invertebrates.

Metalaxyl: Metalaxyl is a systemic fungicide. Registered uses include potatoes, strawberries, citrus, avocados and vegetables. Environmental fate and toxicity data in Tables 3 and 4 indicate that metalaxyl (1) is easily lost from soil by leaching and has a moderate potential for loss due to

surface adsorption and surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioaccumulate significantly. The only concentration of metalaxyl detected was 0.058 µg/L at GORDYRD (Table 2). Using these criteria, the concentrations of metalaxyl detected should not have an acute, harmful impact on fish or aquatic invertebrates.

Metolachlor: Metolachlor is a selective herbicide used on potatoes, sugarcane, and some vegetables. Environmental fate and toxicity data in Tables 3 and 4 indicate that metolachlor (1) has a large potential for loss due to leaching and a medium potential for loss in surface solution and due to surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Metolachlor is non-toxic to birds (Lyman et al., 1990). The only surface water concentration found in this sampling event (0.40 µg/L at S7) is over two orders of magnitude below the calculated chronic action level. Using these criteria, these levels should not have a harmful impact on fish or aquatic invertebrates.

Norflurazon: Norflurazon is a selective herbicide registered for use on many crops including citrus. Environmental fate and toxicity data in Tables 4 and 5 indicate that norflurazon (1) is easily lost from soil surface solution and a moderate potential for loss due to leaching and surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. The LC_{50} for norflurazon is >200 mg/L for catfish and goldfish (Hartley and Kidd, 1987). The norflurazon surface water concentrations ranged from 0.040 to 1.1 µg/L. Even at the highest concentration, this is over an order of magnitude below the calculated chronic action level. Using these criteria, these levels should not have an acute, detrimental impact on fish or aquatic invertebrates. Norflurazon was also detected in the sediment at S80 (36 µg/Kg) and S99 (6.1 µg/Kg). However, no sediment quality assessment guidelines have been developed for norflurazon.

PCBs: Polychlorinated biphenyls (PCBs) is the generic term for a group of 209 congeners that contain a varying number of substituted chlorine atoms on one or both of the biphenyl rings. PCB-1254 and PCB 1260 is a commercial grade mixture containing 54% and 60%, respectively, chlorine by weight. Production of PCBs was banned in 1978 and closed system uses are being phased out. In natural water systems, PCBs are found primarily sorbed to suspended sediments due to the very low solubility in water (Callahan et al., 1979). The tendency of PCBs for adsorption increases with the degree of chlorination and with the organic content of the adsorbent. While the production ban, phase out of uses, and stringent spill clean-up requirements have significantly reduced environmental loadings in recent years, the persistence and tendency to accumulate in sediment and bioaccumulate in fish, make this class of organochlorine compounds especially problematic. Florida sediment quality assessment guidelines have been developed for total PCBs in coastal sediments (FDEP, 1994b). However, an evaluation of the reliability of the sediment quality assessment guidelines for total PCBs suggests a low degree of confidence can be placed on these guidelines due to the insufficient data used in their development. The TEL is 21.6 µg/Kg and the PEL 189 µg/Kg for PCB's. The sediment residues detected at S79 (36 µg/Kg) and S8 (120 µg/Kg) has a possibility for impacting wildlife. None of the PCB congeners were detected in the surface water.

Prometon: Prometon is a non-selective systemic herbicide registered for use in non-crop areas.

Environmental fate and toxicity data in Tables 4 and 5 indicate that prometon (1) is easily lost from soil by leaching, with moderate loss from surface adsorption or surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. The highest concentration of prometon detected (0.043 µg/L at S38B) is several orders of magnitude below the calculated chronic action level. Using these criteria, these levels should not have an acute, detrimental impact on fish or aquatic invertebrates. Prometon was not detected in the sediment.

Simazine: Simazine is a selective systemic herbicide registered for use on many crops including sugarcane, citrus, corn, and non-crop areas. Environmental fate and toxicity data in Tables 4 and 5 indicate that simazine (1) is easily lost from soil by leaching and has a moderate potential for loss due to surface adsorption and surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96 hour LC_{50} of 49 mg/L for guppies (Hartley and Kidd, 1987). Most of the aquatic biological effects occur at concentrations > 500 µg/L (Verschueren, 1983). Aquatic invertebrate LC_{50} toxicity ranges from 3.2 mg/L to 100 mg/L for simazine (U.S. Environmental Protection Agency, 1984). The highest surface water concentration of simazine detected at GORDYRD (0.55 µg/L) was below any level of concern for fish or aquatic invertebrates. No simazine was detected in the sediment.

Quality Assurance Evaluation

Replicate samples were collected at sites S177 and S4. All the analytes detected in the surface water had precision ≤ 30% RPD. No analytes were detected in the field blanks collected at S177, S3, S31 and S4. No pesticide analytes were detected in the equipment blanks performed at ACME1DS, S38B, S18C and S99. All samples were shipped and all bottles were received.

Low concentrations of representative analytes from each pesticide group/method were added to laboratory water as well as to samples submitted. Lab fortified blanks for chlordane did not meet the specified requirements for the water samples collected at the following locations: S99, GORDYRD, S80, S2, S3 S4 (including field blank and replicates), S79, CR33.5T, S78 S235, FECSR78, S65E, and S191. Matrix spike recoveries for beta endosulfan and precision for alpha BHC, DDD, DDE, delta BHC, dieldrin, endosulfan sulfate, and endrin aldehyde did not meet the specified requirements for the water samples collected at the following locations: S7, S38B, NSIDWC06, NSIDWC07, S6, S5A, ACME1DS (including field blank), and G94D. The remainder of the analytes for each sample adhered to the targets for precision and accuracy as outlined in the FDEP Comprehensive Quality Assurance Plan. Organic quality assurance targets are set according to historically generated data or are adapted from the U.S. Environmental Protection Agency with slight modifications or internal goals, based on FDEP limited data. Parameters with low or high recoveries indicate that the sample matrix interferes with these analyses and interpretation of the respective analytical results should consider this effect.

Glossary

LD_{50}: The dosage which is lethal to 50% of the terrestrial animals tested within a short (acute) exposure period, usually 24 to 96 hours.

LC_{50}: A concentration which is lethal to 50% of the aquatic animals tested within a short (acute) exposure period, usually 24 to 96 hours.

EC_{50}: A concentration necessary for 50% of the aquatic species tested to exhibit a toxic effect short of mortality (e.g., swimming on side or upside down, cessation of swimming) within a short (acute) exposure period, usually 24 to 96 hours.

Koc: The soil/sediment partition or sorption coefficient normalized to the fraction of organic carbon in the soil. This value provides an indication of the chemical's tendency to partition between soil organic carbon and water.

Bioconcentration Factor:
The ratio of the concentration of a contaminant in an aquatic organism to the concentration in water, after a specified period of exposure via water only. The duration of exposure should be sufficient to achieve a near steady-state condition.

Soil or water half-life:
The time required for one-half the concentration of the compound to be lost from the water or soil under the conditions of the test.

MDL: The minimum concentration of an analyte that can be detected with 99% confidence of its presence in the sample matrix.

PQL: The lowest level of quantitation that can be reliably achieved within specified limit of precision and accuracy during routine laboratory operating conditions. The PQL is further verified by analyzing spike concentrations whose relative standard deviation in 20 fortified water samples is < 15%. In general, the PQL is 2 to 5 times larger than the MDL.

TEL: The threshold effects level represents the upper limit of the range of sediment contaminant concentrations dominated by no effect data entries, or the minimal effects range. Within this range, concentrations of sediment-associated contaminants are not considered to represent significant hazards to aquatic organisms

PEL: The probable effects level was calculated to define the lower limit of the range of contaminant concentrations that are usually or always associated with adverse biological effects or the lower limit of the probable effects range. Within the probable effects range, concentrations of sediment-associated contaminants are considered to represent significant and immediate hazards to aquatic organisms.

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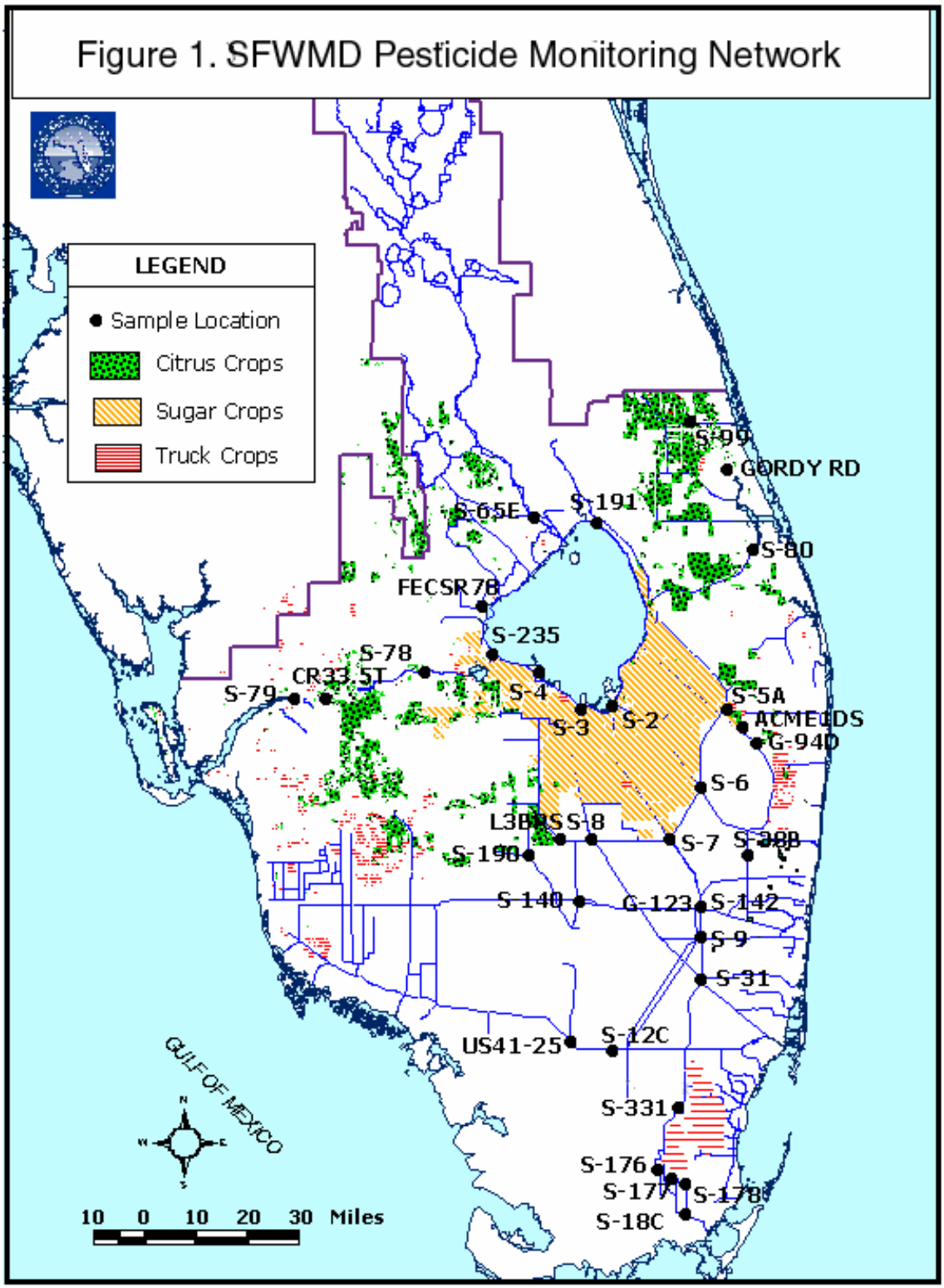
Figure 1. SFWMD Pesticide Monitoring Network
LEGEND
Sample Location
Citrus Crops
Sugar Crops
Truck Crops
S-99
GORDY RD
S-65E
S-191
S-80
FECSR78
S-235
S-78
CR33 5T
S-79
S-4
S-3
S-2
S-5A
ACMEDS
G-94D
S-6
L3BSS
S-8
S-7
S-38B
S-190
S-140
G-123
S-142
S-9
S-31
US41-25
S-12C
S-331
S-176
S-177
S-178
S-18C
GULF OF MEXICO
10 0 10 20 30 Miles

Table 1. Minimum detection limits (MDL) and practical quantitation limits (PQL) for pesticides analyzed in June 2002.

Pesticide or metabolite	Water: range of MDL-PQL (µg/L)	Sediment: range of MDL-PQL (µg/Kg)	Pesticide or metabolite	Water: range of MDL-PQL (µg/L)	Sediment: range of MDL-PQL (µg/Kg)
2,4-D	0.8 - 3.2	17 - 520	endosulfan sulfate	0.0019 - 0.0192	0.88 - 24.8
2,4,5-T	0.8 - 3.2	17 - 520	endrin	0.019 - 0.088	1.6 - 48
2,4,5-TP (silvex)	0.8 - 3.2	17 - 520	endrin aldehyde	0.0042 - 0.0192	0.82 - 24.8
alachlor	0.047 - 0.216	25 - 760	ethion	0.019 - 0.088	2.1 - 60
aldrin	0.0021 - 0.0096	0.41 - 12.4	ethoprop	0.019 - 0.088	4.1 - 124
ametryn	0.0094 - 0.044	2.1 - 60	fenamiphos (nemacur)	0.028 - 0.132	16 - 480
atrazine	0.0094 - 0.192	2.1 - 60	fonofos (dyfonate)	0.019 - 0.088	4.1 - 124
atrazine desethyl	0.0094 - 0.044	N/A	heptachlor	0.0023 - 0.0104	0.41 - 12.4
atrazine desisopropyl	0.0094 - 0.044	N/A	heptachlor epoxide	0.0019 - 0.0088	0.41 - 12.4
azinphos methyl (guthion)	0.019 - 0.088	2.1 - 60	hexazinone	0.019 - 0.088	8.2 - 248
α-BHC (alpha)	0.0021 - 0.0096	0.41 - 12.4	imidacloprid	0.2 - 0.4	N/A
β-BHC (beta)	0.0032 - 0.0148	0.41 - 12.4	linuron	0.2 - 0.4	8.2 - 120
δ-BHC (delta)	0.0021 - 0.0096	0.82 - 24.8	malathion	0.028 - 0.132	6.2 - 184
γ-BHC (gamma) (lindane)	0.0019 - 0.0088	0.41 - 12.4	metalaxyl	0.047 - 0.216	N/A
bromacil	0.038 - 0.172	16 - 480	methamidophos	N/A	21 - 600
butylate	0.019 - 0.088	N/A	methoxychlor	0.0098 - 0.044	2 - 60
carbophenothion (trithion)	0.015 - 0.068	2 - 60	metolachlor	0.057 - 0.26	21 - 600
chlordane	0.0094 - 0.044	6.2 - 184	metribuzin	0.019 - 0.088	4.1 - 124
chlorothalonil	0.015 - 0.068	2 - 60	mevinphos	0.057 - 0.308	8.2 - 248
chlorpyrifos ethyl	0.019 - 0.088	2.1 - 60	mirex	0.011 - 0.052	1.6 - 48
chlorpyrifos methyl	0.0094 - 0.044	4.1 - 124	monocrotophos (azodrin)	N/A	41 - 1240
cypermethrin	0.019 - 0.088	2 - 60	naled	0.075 - 0.348	33 - 1000
DDD-P,P'	0.0045 - 0.0208	0.82 - 24.8	norflurazon	0.019 - 0.088	4.1 - 124
DDE-P,P'	0.0038 - 0.0172	0.82 - 31.6	parathion ethyl	0.019 - 0.088	6.2 - 184
DDT-P,P'	0.0038 - 0.0172	1.2 - 36.8	parathion methyl	0.019 - 0.088	6.2 - 184
demeton	0.11 - 0.52	41 - 1240	PCB	0.019 - 0.088	8.6 - 560
diazinon	0.019 - 0.088	4.1 - 124	permethrin	0.015 - 0.068	2.5 - 180
dicofol (kelthane)	0.042 - 0.192	6.2 - 184	phorate	0.028 - 0.132	2.1 - 60
dieldrin	0.0019 - 0.0088	0.41 - 12.4	prometryn	0.019 - 0.088	6.2 - 184
disulfoton	0.019 - 0.088	4.1 - 124	prometon	0.019 - 0.088	N/A
diuron	0.2 - 0.4	8.2 - 120	simazine	0.0094 - 0.044	2.1 - 60
α-endosulfan (alpha)	0.0038 - 0.0172	0.41 - 12.4	toxaphene	0.071 - 0.328	31 - 920
β-endosulfan (beta)	0.0038 - 0.0172	0.41 - 12.4	trifluralin	0.0075 - 0.0348	1.6 - 48

N/A - not analyzed

Table 2. Summary of pesticide residues (µg/L) above the method detection limit found in surface water samples collected by SFWMD in June 2002.

Date	Site	Flow	ametryn	atrazine	atrazine desethyl	atrazine desisopropyl	bromacil	diuron	fonofos (dyfonate)	hexazinone	metalaxyl	metolachlor	norflurazon	prometon	simazine	Number of compounds detected at site
6/2/2002	S12C	N	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	S176	N	-	0.071	-	-	-	-	-	-	-	-	-	-	-	1
	S177	Y	-	0.016 I*	-	-	-	-	-	-	-	-	-	-	-	1
	S178	N	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	S18C	Y	-	0.035 I	-	-	-	-	-	-	-	-	-	-	-	1
	S331	N	-	0.12	0.013 I	-	-	-	-	-	-	-	-	-	-	2
	S332	N	-	0.045	-	-	-	-	-	-	-	-	-	-	-	1
	S355A	N	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	S355B	N	-	0.015 I	-	-	-	-	-	-	-	-	-	-	-	1
	S8	N	0.014 I	0.33	0.061	0.027 I	-	-	-	-	-	-	-	-	0.016 I	5
	US41-25	N	-	-	-	-	-	-	-	-	-	-	-	-	-	0
6/3/2002	G123	N	-	0.012 I	-	-	-	-	-	-	-	-	-	-	-	1
	L3BRS	N	0.016 I	0.19	0.034 I	-	-	-	-	-	-	-	-	-	0.013 I	4
	S140	N	-	0.15	0.013 I	-	-	-	-	0.034 I	-	-	-	-	-	3
	S142	N	0.019 I	0.15	0.029 I	-	-	-	-	-	-	-	-	-	-	3
	S190	N	-	0.023 I	-	-	-	-	-	-	-	-	0.04 I	-	-	2
	S31	N	-	0.083	-	-	-	-	-	-	-	-	-	-	-	1
	S9	Y	-	0.099	0.011 I	-	-	-	-	-	-	-	-	-	-	2
6/4/2002	ACME1DS	N	0.024 I	0.17	0.024 I	-	-	-	-	-	-	-	-	-	-	3
	G94D	N	0.019 I	0.082	0.011 I	-	-	-	-	-	-	-	-	-	-	3
	NSIDWC06	N	-	1.6	0.14	0.038 I	-	-	-	-	-	-	-	-	-	3
	NSIDWC07	N	0.019 I	2.8	0.33	-	-	-	0.021 I	-	-	-	-	0.030 I	0.011 I	6
	S38B	N	0.012 I	2.3	0.21	-	-	-	-	-	-	-	-	0.043 I	-	4
	S5A	Y	-	0.32	0.076	0.030 I	-	-	-	-	-	-	-	-	0.022 I	4
	S6	Y	0.016 I	0.28	-	0.030 I	-	-	-	-	-	-	-	-	0.019 I	4
	S7	N	0.022 I	1.6	0.15	-	-	-	-	-	-	0.40	-	-	0.048	5
6/5/2002	C25S99	N	-	-	-	0.032 I	0.41	0.22 I	-	-	-	-	0.67	-	0.21	5
	CR33.5T	R	-	0.22	0.057	0.020 I	0.15 I	-	-	-	-	-	0.094	-	0.078	6
	FECSR78	N	-	0.064	0.019 I	-	-	-	-	0.071 I	-	-	-	-	-	3
	GORDYRD	Y	-	-	-	-	0.23	0.35 I	-	-	0.058 I	-	1.1	-	0.55	5
	S191	N	-	0.039	-	-	-	-	-	-	-	-	-	-	-	1
	S2	N	0.011 I	0.27	0.061	0.022 I	-	-	-	-	-	-	-	-	0.018 I	5
	S235	N	-	0.22	-	0.014 I	-	-	-	-	-	-	-	-	0.017 I	3
	S3	Y	-	0.26	-	0.017 I	-	-	-	-	-	-	-	-	0.019 I	3
	S4	N	0.010 I*	0.28 *	-	0.018 I*	-	-	-	-	-	-	-	-	0.021 I*	4
	S65E	Y	-	0.13	0.022 I	-	-	-	-	-	-	-	-	-	-	2
	S78	N	0.013 I	0.58	0.063	0.021 I	-	-	-	-	-	-	-	-	0.022 I	5
	S79	N	0.011 I	0.23	0.049	0.034 I	0.53	-	-	-	-	-	0.19	-	0.34	7
	S80	N	-	0.089	0.018 I	0.014 I	-	-	-	-	-	-	0.25	-	0.10	5
Total number of compound detections			13	33	20	13	4	2	1	2	1	1	6	2	16	

N - no Y - yes R - reverse; - denotes that the result is below the MDL; * results are the averge of duplicate samples

I - value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection limit

Table 3. Summary of pesticide residues (µg/Kg) above the method detection limit found in sediment samples collected by SFWMD in June 2002.

Date	Site	Flow	ametryn	DDD-P,P'	DDE-P,P'	DDT-P,P'	endosulfan alpha	endosulfan beta	endosulfan sulfate	ethion	norflurazon	PCB-1254	PCB-1260	Number of compounds detected at site
6/2/2002	S177	Y	-	-	4.6 I *	-	-	-	-	-	-	-	-	1
	S178	N	-	-	16	-	2.2 I	5.0 I	24	-	-	-	-	4
6/3/2002	S8	N	-	-	3.9 I	-	-	-	-	-	-	-	120	2
6/4/2002	ACME1DS	N	-	-	6.1	-	-	-	-	-	-	-	-	1
	G94D	N	-	-	1.9 I	-	-	-	-	-	-	-	-	1
	S5A	Y	-	91	300	11 I	-	-	-	-	-	-	-	3
	S6	Y	9.5 I	11	36	-	-	-	-	-	-	-	-	3
	S7	N	4.0 I	-	18	-	-	-	-	-	-	-	-	2
6/5/2002	C25S99	N	-	-	-	-	-	-	-	5.1 I	6.1 I	-	-	2
	S2	N	22 I	22	73	-	-	-	-	-	-	-	-	3
	S3	Y	-	-	7.4	-	-	-	-	-	-	-	-	1
	S4	N	23 I *	-	17 I *	-	-	-	-	-	-	-	-	2
	S79	N	-	-	4.6 I	-	-	-	-	-	-	36 I	-	2
	S80	N	-	-	4.8 I	-	-	-	-	12 I	36 I	-	-	3
Total number of compound detections			4	3	13	1	1	1	1	2	2	1	1	

N - no Y - yes R - reverse; - denotes that the result is below the MDL; * results are the averge of duplicate samples

I - value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection limit

Table 4. Selected properties of pesticides found in June 2002 sampling event.

common name	Surface Water Standards 62-302 (µg/L)	Ground Water Guidance Conc. (µg/L)	LD50 acute rats oral (mg/kg) (1)	EPA carcinogenic potential	Water Solubility (mg/L) (2, 3)	Koc (mL/g) (2, 3)	soil half-life (days) (2, 3)	SCS rating (2)			Bioconcentration Factor (BCF)
								LE	SA	SS	
ametryn	-	63	1110	D	185	300	60	M	M	M	33
atrazine	-	3**	3080	C	33	100	60	L	M	L	86
bromacil	-	90	5200	C	700	32	60	L	M	M	15
DDD, p,p'	-	0.1	3400	-	0.055	239900	-	-	-	-	3173
DDE, p,p'	-	0.1	880	-	0.065	243220	-	-	-	-	2887
DDT, p,p'	0.001	0.1	113	-	0.00335	140000	-	-	-	-	15377
diuron	-	14	3400	D	42	480	90	M	M	L	75
endosulfan-alpha	0.056	0.35	70	-	0.53	12400	50	XS	L	M	884
endosulfan-beta	-	0.35	70	-	0.28	-	-	-	-	-	1267
endosulfan-sulfate	-	0.3	-	-	0.117	-	-	-	-	-	2073
ethion	-	3.5	208	-	1.1	8900	150	S	L	M	586
fonofos	-	14	8 -17.5	E	16.9	870	40	S	S	M	125
hexazinone	-	231	1690	D	33000	54	90	L	M	M	2
metalaxyl	-	420	669	-	7100	100	70	L	M	M	4
metolachlor	-	1050	2780	C	530	200	90	L	M	M	18
norflurazon	-	280	9400	C	28	700	90	M	M	L	94
PCB's	0.014	0.5**	-	B2	-	-	-	-	-	-	-
prometon	-	105	2980	-	720	200	500	L	M	M	15
simazine	-	4**	>5000	C	6.2	130	60	L	M	M	221

SCS Ratings are pesticide loss due to leaching (LE), surface adsorption (SA) or surface solution (SS) and grouped as large(L), medium (M), small (S) or extra small (XS)
Volatility from water: R = rapid, I = insignificant, S = significant
Bioconcentration Factor (BCF) calculated as BCF = 10^(2.791 - 0.564 log WS) (4)
B2: probable human carcinogen; C: possible human carcinogen; D: not classified; E: evidence of non-carcinogen for humans (5)
FDEP surface water standards (4/95) for Class III waters except Class I in ( )
Note: endosulfan usually considered the sum of alpha and beta isomers
** primary standard

(1) Hartley, D. and H. Kidd. (Eds.) (1987). The Agrochemicals Handbook. Second Edition, The Royal Society of Chemistry. Nottingham, England.
(2) Goss, D. and R. Wauchope. (Eds.) (1992). The SCS/ARS/CES Pesticide Properties Database: II Using It With Soils Data In A Screening Procedure. Soil Conservation Service. Fort Worth, TX.
(3) Montgomery, J.H. (1993). Agrochemicals Desk Reference: Environmental Data. Lewis Publishers. Chelsa, MI.
(4) Lyman,W.J., W.F. Reehl, and D.H. Rosenblatt. (1990). Handbook of Chemical Property Estimation Methods. American Chemical Society, Washington, DC.
(5) U.S. Environmental Protection Agency (1996). Drinking Water Regulations and Health Advisories. Office of Water. EPA 822-B-96-002.

Table 5 . Toxicity of pesticides found in the June 2002 sampling event to freshwater aquatic invertebrates and fishes (ug/L).

common name	48 hr EC50 Water flea Daphnia magna		acute toxicity (*)	chronic toxicity (*)	96 hr LC50 Fathead Minnow (#) Pimephales promelas		acute toxicity	chronic toxicity	96 hr LC50 Bluegill Lepomis macrochirus		acute toxicity	chronic toxicity	96 hr LC50 Largemouth Bass Micropterus salmoides		acute toxicity	chronic toxicity	96 hr LC50 Rainbow Trout (#) Oncorhynchus mykiss		acute toxicity	chronic toxicity	96 hr LC50 Channel Catfish Ictalurus punctatus		acute toxicity	chronic toxicity
ametryn	28,000	(8)	9333	1400	-		-	-	4,100	(5)	1367	205	-		-	-	8,800	(5)	2933	440	-		-	-
atrazine	6900	(8)	2300	345	15,000	(8)	5000	750	16,000	(5)	5333	800	-		-	-	8,800	(5)	2933	440	7,600	(5)	2533	380
bromacil	-		-	-	-		-	-	127,000	(8)	42333	6350	-		-	-	36,000	(8)	12000	1800	-		-	-
DDD, p,p'	3,200	(7)	1067	160	4,400	(1)	1467	220	42	(1)	14	2.1	42	(1)	14	2.1	70	(1)	23.3	3.5	1,500	(1)	500	75
DDE, p,p'	-		-	-	-		-	-	240	(1)	80	12	-		-	-	32	(1)	10.7	1.6	-		-	-
DDT, p,p'	-		-	-	19	(6)	6.3	0.95	8	(6)	2.7	0.4	2	(6)	0.7	0.10	7	(6)	2.3	0.35	16	(6)	5.3	0.8
diuron	1,400	(8)	467	70	14,200	(8)	4733	710	5,900	(5)	1967	295	-		-	-	5,600	(5)	1867	280	-		-	-
endosulfan	166	(8)	55	8	1	(1)	0.3	0.05	1	(1)	0.33	0.05	-		-	-	1	(1)	0.33	0.050	1	(1)	0.3	0.05
	-		-	-	-		-	-	2	(3)	0.67	0.10	-		-	-	3	(2)	1	0.15	1.5	(8)	0.5	0.08
	-		-	-	-		-	-	-		-	-	-		-	-	1	(3)	0.33	0.050	-		-	-
	-		-	-	-		-	-	-		-	-	-		-	-	0.3	(6)	0.10	0.015	-		-	-
ethion	0.06	(1)	0.02	0.003	720	(1)	240	36	210	(1)	70	11	173	(1)	58	9	500	(1)	167	25	7,600	(1)	2533	380
	-		-	-	-		-	-	13	(3)	4.3	0.65	150	(4)	50	8	193	(3)	64	10	7,500	(4)	2500	375
	-		-	-	-		-	-	22	(4)	7.3	1.1	-		-	-	560	(4)	187	28	-		-	-
fonofos	-		-	-	-		-	-	45	(10)	15	2	-		-	-	110	(10)	37	6	-		-	-
hexazinone	151,600	(8)	50533	7580	274,000	(5)	91333	13700	100,000	(8)	33333	5000	-		-	-	180,000	(8)	60000	9000	-		-	-
metalaxyl	28,000	(8)	9333	1400	-		-	-	139,000	(8)	46333	6950	-		-	-	132,000	(8)	44000	6600	-		-	-
metolachlor	23,500	(8)	7833	1175	-		-	-	15,000	(5)	5000	750	-		-	-	2,000	(5)	667	100	4,900	(6)	1633	245
norflurazon	15,000	(8)	5000	750	-		-	-	16,300	(8)	5433	815	-		-	-	8,100	(8)	2700	405	>200,000	(5)	>67,000	>10,000
prometon	-		-	-	-		-	-	40,000	(6)	13333	2000	-		-	-	12,000	(6)	4000	600	-		-	-
simazine	1,100	(8)	367	55	100,000	(8)	33333	5000	90,000	(5)	30000	4500	-		-	-	100,000	(8)	33333	5000	-		-	-

(*) Florida Administrative Code (FAC) 62-302.200, for compounds not specifically listed, acute and chronic toxicity standards are calculated as one-third and one-twentieth, respectively, of the amount lethal to 50% of the test organisms in 96 hours, where the 96 hour LC50 is the lowest value which has been determined for a species significant to the indigenous aquatic community.

(#) Species is not indigenous. Information is given for comparison purposes only.

(1) Johnson, W. W. and M.T. Finley (1980). Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. U.S. Department of the Interior, Fish and Wildlife Service Resource Publication 137. Washington, DC.

(2) U.S. Environmental Protection Agency (1977). Silvacultural Chemicals and Protection of Water Quality. Seattle, WA. EPA-910/9-77-036.

(3) Schneider, B.A. (Ed.) (1979). Toxicology Handbook, Mammalian and Aquatic Data, Book 1: Toxicology Data. U.S. Environmental Protection Agency. U.S. Government Printing Office. Washington, DC. EPA-5400/9-79-003

(4) U.S. Environmental Protection Agency (1972). Effects of Pesticides in Water: A Report to the States. U.S. Government Printing Office. Washington, DC.

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(6) Montgomery, J.H. (1993). Agrochemicals Desk Reference: Environmental Data. Lewis Publishers. Chelsa, MI.

(7) Verschueren, K. (1983). Handbook of Environmental Data on Organic Chemicals. Second Edition, Van Nostrand Reinhold Co. Inc. New York, NY.

(8) U.S. Environmental Protection Agency (1991) Pesticide Ecological Effects Database, Ecological Effects Branch, Office of Pesticide Programs, Washington, DC.

Table 6. Atrazine Desethyl/Atrazine ratio (DAR) data for June 2002

Date	Site	Flow	atrazine ug/l	moles/l	atrazine desethyl ug/l	moles/l	DAR
6/2/2002	**S331**	N	0.12	5.56367E-10	0.013	6.92847E-11	0.1
	S8	N	0.33	1.53001E-09	0.061	3.25105E-10	0.2
6/3/2002	**L3BRS**	N	0.19	8.80914E-10	0.034	1.81206E-10	0.2
	S140	N	0.15	6.95458E-10	0.013	6.92847E-11	0.1
	S142	N	0.15	6.95458E-10	0.029	1.54558E-10	0.2
	S9	Y	0.099	4.59002E-10	0.011	5.86256E-11	0.1
6/4/2002	**ACME1DS**	N	0.17	7.88186E-10	0.024	1.2791E-10	0.2
	G94D	N	0.082	3.80184E-10	0.011	5.86256E-11	0.2
	NSIDWC06	N	1.6	7.41822E-09	0.14	7.46143E-10	0.1
	NSIDWC07	N	2.8	1.29819E-08	0.33	1.75877E-09	0.1
	S38B	N	2.3	1.06637E-08	0.21	1.11922E-09	0.1
	S5A	Y	0.32	1.48364E-09	0.076	4.05049E-10	0.3
	S7	N	1.6	7.41822E-09	0.15	7.99439E-10	0.1
6/5/2002	**CR33.5T**	R	0.22	1.02001E-09	0.057	3.03787E-10	0.3
	FECSR78	N	0.064	2.96729E-10	0.019	1.01262E-10	0.3
	S2	N	0.27	1.25182E-09	0.061	3.25105E-10	0.3
	S65E	Y	0.13	6.02731E-10	0.022	1.17251E-10	0.2
	S78	N	0.58	2.68911E-09	0.063	3.35765E-10	0.1
	S79	N	0.23	1.06637E-09	0.049	2.6115E-10	0.2
	S80	N	0.089	4.12639E-10	0.018	9.59327E-11	0.2

N - no flow; Y - flow; R - reverse

DAR	All sites	Flow only sites	No flow sites
average	0.2	0.2	0.2
median	0.2	0.2	0.2
minimum	0.1	0.1	0.1
maximum	0.3	0.3	0.3